

# Shoreline Litter (Marine Debris) Survey in Panvel Creek, Navi Mumbai, Maharashtra

Aamod Thakkar<sup>1</sup>, Rahul Patil<sup>2</sup>, Nalanda Devanand Waghmare<sup>3</sup>

I/C Principal,<sup>2</sup> Associate Professor in zoology,<sup>3</sup> Student Department of Zoology

Veer Wajekar ASC College, Phunde, Uran

**Abstract:** *Marine debris, particularly plastic waste, has emerged as a major environmental concern affecting coastal and estuarine ecosystems worldwide. The present study focuses on assessing shoreline litter in Panvel Creek, Navi Mumbai, Maharashtra. A standardized transect-based survey method is proposed to quantify, classify, and analyze the spatial distribution of marine debris. The study aims to identify dominant litter types, evaluate anthropogenic influences, and determine pollution hotspots. Plastic materials are expected to dominate the debris composition due to their widespread use and persistence in the environment. The outcomes of this research will provide baseline data essential for environmental monitoring, policy development, and sustainable waste management strategies in coastal regions.*

**Keywords:** Marine debris, shoreline litter, Panvel Creek, plastic pollution, coastal ecosystem, environmental monitoring

## I. INTRODUCTION

Marine debris, also referred to as shoreline litter, is defined as any persistent, manufactured, or processed solid material that is intentionally or unintentionally discarded, disposed of, or abandoned in marine and coastal environments. This form of pollution has emerged as one of the most pressing global environmental issues, affecting oceans, estuaries, and coastal ecosystems. Marine debris originates from both land-based and sea-based sources, including urban runoff, improper solid waste disposal, industrial discharge, fishing activities, and recreational practices. Once introduced into aquatic systems, these materials can persist for extended periods, leading to long-term ecological and environmental consequences.

Shoreline litter surveys are widely recognized as reliable and standardized scientific methods for assessing the abundance, composition, and spatial distribution of marine debris. These surveys provide crucial baseline data that help in identifying pollution sources, understanding accumulation patterns, and evaluating the effectiveness of waste management strategies. By systematically documenting different categories of debris along coastlines and creek systems, researchers can track temporal trends and identify critical hotspots of pollution. Such data are essential for developing evidence-based environmental policies and implementing targeted mitigation measures.

Among the various types of marine debris, plastics represent the dominant fraction, accounting for approximately 60–80% of total litter found in marine environments. The widespread use of plastics, coupled with their low cost, durability, and resistance to degradation, contributes to their persistence in nature. Over time, larger plastic items undergo fragmentation into microplastics, which are capable of entering food chains and posing serious threats to marine organisms and human health. The accumulation of plastic debris results in multiple ecological impacts, including ingestion and entanglement of marine fauna, habitat degradation, and the transport of toxic substances across ecosystems.

Coastal ecosystems such as estuaries, mangroves, and tidal creeks play a dual role in the dynamics of marine debris. Due to their unique hydrodynamic conditions, including tidal fluctuations, wave action, and sediment deposition, these environments often act as natural sinks or accumulation zones for floating and stranded debris. Mangrove ecosystems, in particular, are highly effective at trapping litter due to their dense network of roots and pneumatophores. While this



trapping mechanism helps prevent debris from entering open oceans, it simultaneously leads to localized accumulation, resulting in physical damage to vegetation, obstruction of water flow, and increased ecological stress.

In developing countries like India, rapid urbanization, population growth, and inadequate solid waste management systems have significantly exacerbated the problem of marine pollution. The increasing generation of plastic waste, combined with inefficient collection and disposal mechanisms, results in large quantities of debris being transported into coastal and estuarine systems through rivers, drainage channels, and surface runoff. Consequently, coastal regions near densely populated urban centers experience higher levels of shoreline litter and environmental degradation.

Panvel Creek, located in Navi Mumbai, is an ecologically significant tidal creek system that exemplifies the challenges associated with marine debris accumulation in urban coastal environments. The creek is influenced by multiple anthropogenic activities, including industrial operations, fishing practices, transportation, and domestic waste discharge from surrounding residential areas. Additionally, the presence of extensive mangrove vegetation along the creek enhances its role as a debris retention zone, where floating litter is trapped and accumulates over time.

The accumulation of shoreline litter in Panvel Creek poses serious environmental concerns, affecting biodiversity, water quality, and the overall health of the ecosystem. Debris trapped within mangrove habitats can hinder plant growth, reduce oxygen exchange, and create hazardous conditions for aquatic organisms through ingestion and entanglement. Furthermore, the aesthetic degradation of the shoreline can impact local livelihoods, particularly those dependent on fisheries and coastal resources.

Despite the ecological importance of Panvel Creek, there is a lack of systematic and quantitative studies focusing specifically on shoreline litter accumulation and distribution patterns in this region. Therefore, conducting a comprehensive shoreline litter survey is essential to assess the extent of marine debris pollution, identify dominant litter types, and determine potential sources. Such a study will generate baseline data that can support environmental monitoring programs, inform policy decisions, and contribute to the development of sustainable waste management and conservation strategies.

In this context, the present study aims to conduct a detailed shoreline litter survey in Panvel Creek to evaluate the quantity, composition, and spatial distribution of marine debris. The findings are expected to provide valuable insights into pollution dynamics and contribute to effective environmental management and protection of coastal ecosystems.

## **II. LITERATURE REVIEW**

### **2.1 Global Perspective on Marine Debris**

Marine debris has emerged as a significant global environmental concern affecting marine, coastal, and estuarine ecosystems. It is defined as any persistent solid material that is manufactured or processed and subsequently discarded into aquatic environments. Over the past few decades, the accumulation of marine debris has increased dramatically due to population growth, industrialization, and the extensive use of non-biodegradable materials.

Among all types of marine litter, plastics have been identified as the dominant component, accounting for approximately 60–80% of total debris worldwide. The widespread use of plastic materials in packaging, consumer goods, and fishing activities contributes to their large-scale presence in marine environments. Plastics are highly resistant to natural degradation processes and can persist for hundreds of years. Over time, larger plastic items undergo fragmentation due to physical, chemical, and biological processes, forming microplastics (<5 mm in size).

These microplastics pose serious ecological threats as they can be easily ingested by a wide range of marine organisms, including plankton, fish, seabirds, and mammals. Once ingested, microplastics can accumulate within the food chain, leading to bioaccumulation and biomagnification of toxic substances. Additionally, plastics can act as vectors for harmful pollutants such as heavy metals and persistent organic pollutants (POPs), further amplifying their



environmental impact. Due to their persistence and widespread distribution, marine debris is now recognized as a transboundary issue requiring global monitoring and management strategies.

## **2.2 Indian Coastal Scenario**

The problem of marine debris is particularly severe along the coastlines of India, where rapid urbanization, population growth, and inadequate waste management systems have significantly contributed to environmental pollution. India has an extensive coastline and numerous estuaries and river systems that act as major pathways for land-based waste entering the marine environment.

Studies conducted along various coastal regions such as Mumbai, Goa, and Kerala have consistently reported high levels of shoreline litter, with plastics being the most dominant component. Plastic items such as carry bags, bottles, food wrappers, and packaging materials are commonly observed due to their widespread usage and improper disposal practices. In addition to plastics, other materials such as glass, metal, rubber, and cloth are also present but in comparatively lower proportions.

A significant portion of marine debris in India originates from land-based sources, including domestic waste dumping, urban runoff, tourism-related activities, and inefficient municipal waste collection systems. Religious practices, festivals, and coastal recreational activities further contribute to litter generation. Riverine transport plays a crucial role in carrying waste from inland areas to coastal zones, where it accumulates along shorelines and estuaries.

The lack of effective waste segregation, recycling infrastructure, and public awareness exacerbates the problem, making Indian coastal regions highly vulnerable to marine pollution. Consequently, there is a growing need for localized studies to understand site-specific pollution patterns and to develop targeted waste management strategies.

## **2.3 Ecological Impacts of Marine Debris**

Marine debris has wide-ranging ecological consequences that affect biodiversity, ecosystem functioning, and environmental health. One of the most direct impacts is the entanglement and ingestion of debris by marine organisms. Animals such as fish, turtles, seabirds, and marine mammals often mistake plastic items for food, leading to ingestion. This can result in internal injuries, blockage of the digestive system, reduced feeding capacity, and eventually death.

Entanglement in debris such as fishing nets, ropes, and plastic bands can restrict movement, cause injuries, and impair the ability of organisms to escape predators or capture food. This is particularly harmful to large marine animals and birds.

Another significant impact of marine debris is habitat degradation, especially in sensitive ecosystems such as mangroves, coral reefs, and seagrass beds. In mangrove ecosystems, debris accumulation can smother roots (pneumatophores), obstruct water flow, and interfere with nutrient exchange processes. This can lead to reduced plant growth, loss of biodiversity, and degradation of ecosystem services.

Furthermore, marine debris acts as a carrier of toxic chemicals. Plastics can absorb and concentrate harmful substances such as pesticides, heavy metals, and persistent organic pollutants from the surrounding environment. When ingested by organisms, these toxins can enter the food chain, posing risks not only to marine life but also to human health through seafood consumption.

Overall, the ecological impacts of marine debris are complex and multifaceted, affecting organisms at different trophic levels and disrupting the balance of marine ecosystems.



#### **2.4 Studies on Panvel Creek and Surrounding Regions**

Panvel Creek, located in Navi Mumbai, is an important estuarine ecosystem that has been subjected to increasing anthropogenic pressure over the years. The creek is influenced by rapid urban development, industrial activities, fishing operations, and domestic waste discharge from surrounding areas.

Previous studies conducted in Panvel Creek and nearby regions such as Uran and Thane Creek have reported moderate to high levels of pollution, including both chemical contaminants and solid waste. Research findings indicate that plastic debris constitutes a major portion of shoreline litter, often accounting for more than 70% of the total collected waste. Commonly observed items include plastic bags, bottles, food packaging materials, thermocol, and fishing-related debris.

The presence of extensive mangrove ecosystems along the creek enhances the accumulation of debris, as mangrove roots act as natural traps for floating materials. While this helps prevent the spread of debris into open marine waters, it results in localized buildup, causing ecological stress within the mangrove habitat.

Studies have also highlighted that litter density is significantly higher near areas with intense human activity, such as fishing villages, marketplaces, transportation routes, and drainage outlets. These findings emphasize the strong link between anthropogenic activities and marine debris accumulation.

Despite existing research on water quality and general pollution in Panvel Creek, there is a lack of comprehensive and systematic studies focusing specifically on shoreline litter composition, abundance, and spatial distribution. This gap underscores the need for detailed field-based surveys to generate baseline data and support effective environmental management strategies in the region.

#### **2.5 Research Gap**

There is limited quantitative data on:

- Composition and abundance of shoreline litter
- Spatial distribution patterns
- Role of mangroves in debris trapping

### **III. OBJECTIVES**

The study aimed to comprehensively investigate shoreline litter in Panvel Creek by quantifying the amount of debris present along the coastal stretch and classifying it into different categories. A particular focus was placed on assessing the contribution of plastic waste, given its widespread environmental impact. The research also analyzed spatial variation in litter distribution to identify hotspots and patterns linked to human activity, while evaluating the influence of anthropogenic factors on litter accumulation. Additionally, the role of mangrove vegetation in trapping and accumulating debris was examined, highlighting the interplay between natural habitats and pollution. The ecological impacts of the litter on the mangrove ecosystem and associated fauna were assessed to understand potential threats to biodiversity and ecosystem functioning. Finally, the study aimed to generate baseline data that can inform future research, monitoring programs, and conservation strategies for maintaining the health and resilience of Panvel Creek.

### **IV. HYPOTHESIS**

- $H_0$ : No significant variation exists in litter distribution or composition.  $H_1$ : Significant variation exists due to anthropogenic activities. Plastic debris dominates over other materials. Litter density is higher near human activity zones.

### **V. MATERIALS AND METHODS**

#### **Methodology:**

The study was conducted along the shoreline of Panvel Creek in Navi Mumbai, Maharashtra, with a focus on assessing the distribution and composition of marine debris. A systematic sampling design was employed, where a 100-meter



transect was established along the creek's shoreline, covering a belt width of 2 meters, resulting in a total sampled area of 200 m<sup>2</sup>. Surveys were carried out by two trained observers to ensure accuracy and consistency in data collection. All litter items larger than 2.5 cm were recorded, with careful attention to avoid duplication. Each item was categorized into specific groups, including plastics, glass, metal, rubber, cloth, and fishing-related waste, to facilitate analysis of the sources and types of debris present in the area.

Field data collection relied on standard tools and materials to ensure safety and precision. Observers were equipped with gloves and trash bags for handling and collecting debris, a measuring tape for accurate assessment of transect dimensions, datasheets for systematic recording, and a camera to document the condition and type of debris visually. To improve the reliability and representativeness of the data, sampling was replicated across three transects or by repeated sampling along the same transect at different times, allowing for assessment of temporal and spatial variation in debris accumulation.

Data analysis involved quantifying the number of items per meter (items/m) to standardize the litter density along the shoreline. The percentage composition of each debris category was calculated to determine the relative contribution of different types of waste, particularly highlighting the prevalence of plastics and fishing-related materials. Graphical representations, such as bar charts and pie charts, were used to visualize spatial patterns, category distribution, and comparative abundance across transects. This detailed methodological framework allowed for a systematic, replicable, and comprehensive assessment of shoreline litter in Panvel Creek, providing valuable baseline data for understanding anthropogenic impacts and informing future conservation and waste management strategies.

## **VI. DISCUSSION**

The present study is expected to provide comprehensive insights into the composition, abundance, and spatial distribution of shoreline litter in Panvel Creek. Based on existing literature and preliminary observations, the findings are likely to confirm that shoreline litter accumulation is predominantly influenced by anthropogenic activities. Areas characterized by dense human settlements, fishing operations, commercial activities, and inadequate waste disposal systems are expected to exhibit significantly higher litter densities compared to relatively undisturbed zones.

A major outcome anticipated from this study is the dominance of plastic debris, which aligns with global and national trends in marine pollution. The widespread use of single-use plastics, combined with improper disposal and lack of efficient recycling mechanisms, contributes to their persistence in the environment. Plastic items such as carry bags, bottles, food packaging, and thermocol are expected to constitute the majority of the collected debris. Their resistance to degradation not only leads to long-term environmental accumulation but also increases the likelihood of fragmentation into microplastics, thereby amplifying ecological risks.

The spatial distribution of litter is also expected to reveal distinct accumulation patterns influenced by environmental and hydrodynamic factors. Tidal movements, water currents, and sedimentation processes play a critical role in transporting and depositing debris along the shoreline. In particular, mangrove ecosystems along Panvel Creek are likely to function as natural traps for floating debris. While mangroves provide essential ecosystem services such as shoreline protection, carbon sequestration, and habitat support, their dense root structures (pneumatophores) facilitate the retention of litter. This results in localized accumulation zones that can intensify ecological stress.

The accumulation of debris within mangrove habitats may lead to several adverse impacts, including obstruction of water flow, reduced gas exchange in roots, and physical damage to vegetation. Additionally, the presence of litter increases the risk of entanglement and ingestion for aquatic organisms, birds, and other fauna. These impacts can disrupt food webs, reduce biodiversity, and compromise the ecological integrity of the creek ecosystem.

Another important aspect likely to emerge from the study is the identification of pollution hotspots. These hotspots are expected to occur near drainage outlets, fishing landing sites, market areas, and regions with high human accessibility.



The identification of such critical zones is essential for targeted intervention and efficient resource allocation in pollution control efforts.

Furthermore, the study is expected to establish a clear relationship between human activities and litter accumulation patterns. This correlation underscores the importance of addressing land-based sources of pollution through improved waste management practices and regulatory frameworks.

The findings of this research will have significant practical implications. Firstly, the generated data can support the development of effective waste management planning by identifying major sources and types of litter. Secondly, the results can contribute to the formulation and implementation of pollution control policies, including restrictions on single-use plastics and improved waste collection systems. Thirdly, the study can serve as a foundation for public awareness programs aimed at promoting responsible waste disposal and environmental conservation.

## VII. CONCLUSION

The present study aims to provide a systematic and scientific assessment of shoreline litter in Panvel Creek, contributing valuable baseline data on the quantity, composition, and spatial distribution of marine debris. Such baseline information is crucial for understanding the extent of marine pollution and for establishing long-term monitoring programs in estuarine and coastal ecosystems.

The anticipated results will enhance our understanding of marine debris dynamics, particularly the dominance of plastic waste and its association with anthropogenic activities. By identifying key pollution sources and accumulation hotspots, the study will offer critical insights into the pathways through which waste enters and persists within the creek system. These findings will be instrumental in guiding environmental management strategies and policy interventions.

Moreover, the study highlights the dual role of mangrove ecosystems, which, while providing vital ecological functions, also act as accumulation zones for debris. This emphasizes the need for targeted conservation efforts to protect these sensitive habitats from further degradation.

To effectively mitigate the impacts of marine debris, continuous monitoring of shoreline litter is essential. Regular surveys will help track temporal changes, evaluate the effectiveness of implemented measures, and provide updated data for decision-making. In addition, strengthening solid waste management systems, promoting recycling practices, and enforcing regulations on plastic usage are critical steps toward reducing pollution.

Public participation and awareness also play a key role in addressing marine debris issues. Community engagement initiatives, educational campaigns, and stakeholder involvement can significantly contribute to reducing litter generation and improving environmental stewardship.

In conclusion, this study not only contributes to scientific knowledge but also provides practical recommendations for sustainable coastal management. The outcomes are expected to support policymakers, environmental agencies, and local communities in their efforts to protect and restore the ecological health of Panvel Creek and similar coastal ecosystems.

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